

What is claimed is:

1. A solenoid valve for discharging a reactant gas from a fuel cell, comprising:

5 a valve housing having a first port for introducing the reactant gas and a second port for discharging the reactant gas introduced from said first port;

10 a solenoid unit disposed in a casing joined to said valve housing, said solenoid unit being energizable by a current;

a shaft axially displaceable when said solenoid unit is energized;

a valve head disposed in said valve housing and engaging an end of said shaft;

15 a valve seat, said valve head being seatable on and unseatable from said valve seat when said shaft is displaced;

20 a diaphragm attached to said shaft, said diaphragm being flexible in response to displacement of said shaft; and

a restriction disposed in said first port and having an orifice for restricting a flow rate of the reactant gas introduced into the first port.

25 2. A solenoid valve according to claim 1, wherein said first port has a passage defined therein in communication with a chamber in which said valve head is disposed, said

passage housing a filter disposed therein, said restriction being disposed adjacent to said filter upstream thereof.

5 3. A solenoid valve according to claim 1, wherein said diaphragm comprises a base fabric covered with a thin elastomeric layer, said diaphragm having a substantially central area sandwiched between a step of said shaft and a press-fitted fixture press-fitted over an enlarged portion of said shaft.

10 4. A solenoid valve according to claim 1, wherein said valve head is disposed in said valve housing coaxially with said solenoid unit, said valve head being disposed upstream of said diaphragm with respect to a flow of said reactant gas from said first port to said second port.

15 5. A solenoid valve according to claim 4, wherein said solenoid unit has a fixed core disposed therein, and said fixed core and said diaphragm define a space therebetween, said space communicating with outside of said valve housing through a discharge passage for allowing a fluid in said space to be discharged outside of said valve housing.

20 6. A solenoid valve according to claim 5, wherein said discharge passage comprises:

a fluid passage defined in said fixed core;

a communication passage defined in said valve housing

in communication with said fluid passage; and
an air bleeder port communicating with said
communication passage and outside of said valve housing.

5 7. A solenoid valve according to claim 5, wherein an
outer circumferential surface of said shaft and an inner
circumferential surface of said fixed core are spaced from
each other by a distance ranging from 10 to 50 μm .

10 8. A solenoid valve according to claim 1, wherein said
valve head has an engaging hole in which an end of said
shaft engages, with a clearance defined between an outer
circumferential surface of said shaft and an inner
circumferential surface of said engaging hole, further
15 comprising a spring for normally urging said valve head
toward said shaft.

 9. A solenoid valve according to claim 1, further
comprising a first elastic member made of an elastic
20 material mounted on an end face thereof which is to be
seated on said valve seat, and a second elastic member made
of an elastic material mounted on an opposite end face
thereof which is axially remote from said end face.

25 10. A solenoid valve according to claim 1, wherein said
valve seat has a restriction mechanism for restricting a
flow rate of the reactant gas introduced from said first

port.

11. A solenoid valve according to claim 1, wherein said shaft has a surface coated with a fluororesin.

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12. A solenoid valve according to claim 1, wherein said solenoid valve is incorporated in a fuel cell system having a fuel cell stack having an anode and a cathode;

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said solenoid valve being disposed in a hydrogen discharger which is connected to a circulation passage interconnecting an ejector for attracting the reactant gas discharged from the anode and the anode;

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wherein said hydrogen discharger discharges an excessive reactant gas in said fuel cell stack out of the fuel cell system through said circulation passage.

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13. A solenoid valve according to claim 12, wherein said fuel cell system is mounted on vehicles including automobiles.

14. A solenoid valve for discharging a reactant gas from a fuel cell, comprising:

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a valve housing having a first port for introducing the reactant gas and a second port for discharging the reactant gas introduced from said first port;

a solenoid unit disposed in a casing joined to said valve housing, said solenoid unit being energizable by a

current;

a shaft axially displaceable when said solenoid unit is energized;

5 a valve head disposed in said valve housing and engaging an end of said shaft;

a valve seat, said valve head being seatable on and unseatable from said valve seat when said shaft is displaced;

10 a diaphragm attached to said shaft, said diaphragm being flexible in response to displacement of said shaft; and

a restriction mechanism disposed between said valve head and said diaphragm for restricting a flow rate of the reactant gas introduced from said first port.

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15. A solenoid valve according to claim 14, wherein said restriction mechanism comprises an annular ridge projecting from an inner circumferential surface of said valve seat toward said shaft, said annular ridge providing
20 an orifice for restricting the flow rate of the reactant gas.

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16. A solenoid valve according to claim 14, wherein said restriction mechanism comprises an adapter mounted on an inner circumferential surface of said valve seat and having an orifice for restricting the flow rate of the
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reactant gas.

17. A solenoid valve for discharging a reactant gas from a fuel cell, comprising:

5 a valve housing having a first port for introducing the reactant gas and a second port for discharging the reactant gas introduced from said first port;

10 a solenoid unit disposed in a casing joined to said valve housing, said solenoid unit being energizable by a current;

a shaft axially displaceable when said solenoid unit is energized;

a valve head disposed in said valve housing and engaging an end of said shaft;

15 a valve seat, said valve head being seatable on and unseatable from said valve seat when said shaft is displaced; and

20 a flexible member disposed between said casing and said valve housing and attached to said shaft, said flexible member being flexible in response to displacement of said shaft and isolating said solenoid unit disposed in said casing from said valve housing to prevent the reactant gas from leaking into said solenoid unit.

25 18. A solenoid valve according to claim 17, wherein said flexible member comprises a diaphragm made of an elastic material, said diaphragm comprising:

a joint integrally mounted on said shaft;
a skirt extending radially outwardly from said joint;
and

5 a peripheral edge disposed on an outer circumferential
end of said skirt and clamped between a fixed core disposed
in said solenoid unit and said valve housing;

10 the arrangement being such that when said valve head is
seated on said valve seat, a junction between said shaft and
said joint is positioned closer to said valve head than a
lower side near said solenoid unit of an inner
circumferential surface of said second port.

15 19. A solenoid valve according to claim 17, further
comprising a filter mounted in said first port for removing
dust particles contained in said reactant gas.

20 20. A solenoid valve according to claim 17, wherein
said valve head is disposed in said valve head coaxially
with said solenoid unit, said valve head being disposed
upstream of said flexible member with respect to a flow of
said reactant gas from said first port to said second port.

25 21. A solenoid valve according to claim 18, wherein
said diaphragm has a peripheral edge held by a retainer
projecting radially inwardly from said valve housing.

22. A solenoid valve according to claim 17, wherein

said solenoid valve is incorporated in a fuel cell system having a fuel cell stack having an anode and a cathode;

said solenoid valve being disposed in a hydrogen discharger which is connected to a circulation passage interconnecting an ejector for attracting the reactant gas discharged from the anode and the anode;

wherein said hydrogen discharger discharges an excessive reactant gas in said fuel cell stack out of the fuel cell system through said circulation passage.

23. A solenoid valve according to claim 22, wherein said fuel cell system is mounted on vehicles including automobiles.